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PILOT FITNESS, A SAFETY FACTOR IN AVIATION

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IN our thinking as to the comparative importance of pilot fitness as a safety factor in aviation, it is well to keep in mind such views as have been expressed by Major-General James E. Fechet (Ret.), formerly chief of the U.S. Army Air Corps, who has devoted a great deal of time to the study of airplane crashes. Discussing the causes of airplane crashes he says that in more than half the number of cases these are due to personnel error or to undetermined causes. In the personnel group he includes the pilot, the weather man, the airline operations manager and the mechanic. Of these the pilot is of course a very important factor. A small percentage of these crashes—less than five, he says—is due to mechanical failure—engine malfunctions, breakage of some part of the plane or its essential accessories.[1] From this it seems that not the plane but its operation is chiefly at fault.

It is the purpose of this paper to describe an instrument for testing pilot fitness. We have called the instrument an electrical multiple-exposure tachistoscope. It was devised particularly for measuring the speed of adjustment of the eyes for change of distance, the speed of accommodation and the speed of adaptation,

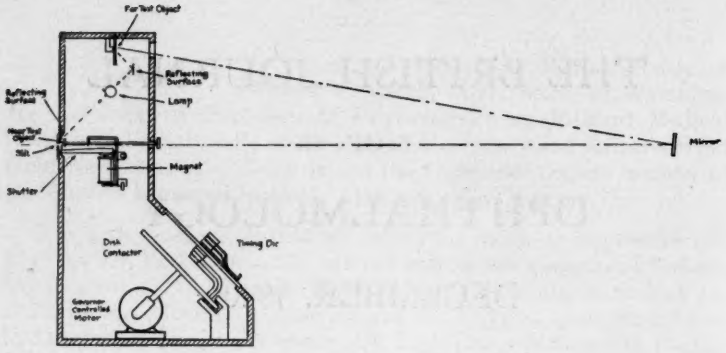

FIG. 1.

Sectioned side elevation of multiple-exposure electrical tachistoscope.

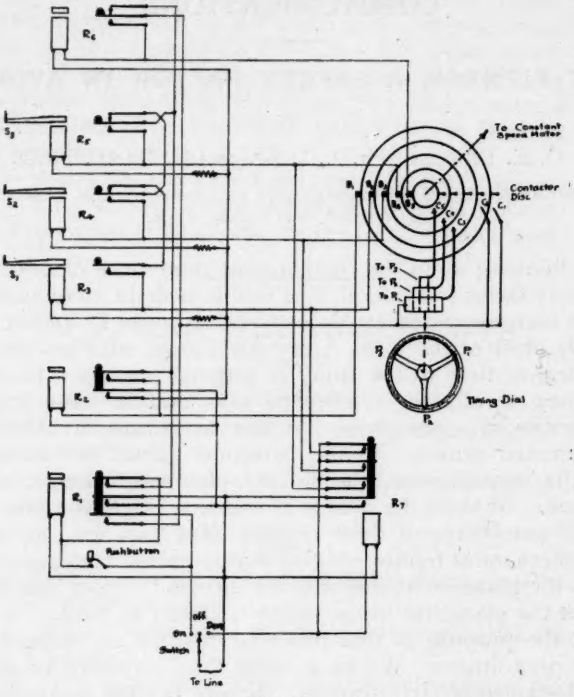

FIG. 2.

A wiring diagram for the multiple-exposure electrical tachistoscope.

FIG. 3.

The electrical tachistoscope in operation at a test station in Chicago. The set-up is for measuring speed of adjustment for change of distance of object.

and for testing ocular and general fatigue. In designing the instrument special attention has been given to compactness of construction, ease of operation and ready portability. A picture of the instrument set up for operation, a sectioned side elevation and a wiring diagram are given in Figs. 1-3.

The instrument comprises a timing mechanism and three shutters, electromagnetically operated, so arranged as to expose in immediate succession a near test-object on the left, a far test-object in the median plane and near test-object on the right. The test-objects are the letter E which can be rotated into four different positions to give an objective check on the judgment. The far test-object is mounted in the same cabinet which contains the near test-objects, the shutters and the timing mechanism, as is shown in the sectioned side elevation (Fig. 1). A front surfaced mirror which is mounted at an appropriate distance from the rear of the cabinet serves to reflect into the viewing slit the image of the far test-object, thus reducing floor space requirements. The distance of the far test-object, the lateral separation of the two near test-objects and the illumination of all three can be varied at will.

The shutters are mounted on light aluminium arms which are attached to the armatures of three relays suitably positioned in the cabinet. The operate and release times of each relay are of the

order of 0·005 sec. On the outside of the cabinet the necessary switches are provided and a timing dial the pointers of which contact a commutator. The dial has 500 divisions each one of which is equal to 0·01 sec. when the commutator rotates at 12 r.p.m. By setting the pointers at the correct position on the dial, the operator may vary the exposure time of any test object at will, provided that the total duration of all the exposures does not exceed the period of one revolution of the commutator (in the above case, 5 sec.). The commutator is driven by a 1/80 h.p. universal governor-controlled D.C. motor with double worm-gear reduction. By varying the speed of the motor the commutator can be given a range of speeds from 6 to 30 r.p.m. The total duration of all the exposures can therefore be varied from 10 to 2 sec. At these limiting ranges the divisions on the dial will equal respectively 0·02 sec. and 0·004 sec. If still longer total exposure-times should be required, this can be arranged for in the reduction gearing of the motor. When alternating current is used, a synchronous motor can be substituted for the governor-controlled motor and a rectifier inserted to convert the current supplied to the shutters.

Uses of the Instrument and Test

The instrument makes possible: (*a*) The use of a set of very sensitive tests which take into account as no other tests do both the motor and the sensory functions of the eyes in just the proportion that they occur in the act of seeing objects in different directions and at different distances. Composite tests of this kind give by direct measurement information that cannot be obtained, and permit of conclusions that cannot be drawn, from any amount or kind of separate testing of functions.

(*b*) The testing of the dynamic speed of vision* with either the oculomotor or the accommodative feature emphasised. The test made with the accommodative feature emphasised gives the speed of accommodation as nearly as possible, it would seem, for that result to be obtained. Similarly, the arrangement of the conditions of the test so as to emphasise the importance of

* There are two types of test for speed of vision: a static test and a dynamic test. In the static test the eyes fixate and accommodate for a given selected distance and the test-object is exposed at that distance for the minimum time needed for its discrimination. Such conditions test only the speed of reaction of the sensorium. They give no information as to the motor functions of the eyes and the effectiveness of their co-ordination for the purpose of seeing. In the dynamic test for speed of vision on the other hand, the eyes are required to shift their regard from one object to another or to a series of objects and to discriminate them in turn during the time or times of exposure. These conditions test not only the speed of reaction of the sensorium but also the oculomotor facility and efficiency.

convergence and divergence in the results measures the speed of these functions as nearly in complete separation as can be accomplished.

(c) The measurement of the time to change from near to far and from far to near either in combination or separately. The measurement of the time required for these shifts separately in the form of the test in which the oculomotor functions are emphasised gives a sensitive comparison of the facility and condition of the converging and diverging mechanisms, which may be more significant and comprehensive than tests of the duction type. Such measurements also provide a way of making a quantitative determination of what the results of the duction tests mean in terms of typical oculomotor performances. In the form of the test in which the accommodative feature is emphasised, the measurement of the time required for the shifts separately gives a comparison of the time required for the action of the muscles of accommodation and the lens material in the change from near to far and from far to near, which may have both a practical and a theoretical bearing. All the aforementioned possibilities of measurement have, we believe, great value in relation to the examination of the eyes in the work of the clinic.

In addition to these clinical applications, the following further uses of the instrument and the measurements it makes possible may be discussed:

1. *A test of vocational fitness in all cases in which dynamic speed of vision is an important requirement.*—Most of the work requiring speed of vision is done with moving eyes. For such work a static test, which tests only the speed of reaction of the sensorium, is incomplete. A quickly reacting sensorium, it is true, gives a quick discrimination of the object and a quicker and more effective guidance of the movement of the eyes. However, it is not nearly so important for the quick use of the eyes in the greater part of work that persons are called on to do as are quick oculomotor and accommodative adjustments. There are many vocations for which a high standard of requirement in this respect is needed. In a machine age in which all industrial performances are quick and public and private conveyances travel at rates of speed that were formerly almost inconceivable, the demands put on the speed of the eyes' reactions have become increasingly rigorous. Further, the requirements of factory workers who operate machines are by no means low. It is our strong belief that ocular tests in which the factor of speed is not given great importance are not a safeguard against either inefficiency of performance or dangerous accident.

2. *A test of pilot fitness for aviation.*—Our first model of multiple-exposure tachistoscope was devised during the World

War to test pilot fitness for aviation.[2] We thought that the eyes of aviators should have a supernormal speed and precision of co-ordinated response in the three fundamental reactions: oculomotor, accommodative and sensory. Only the reaction of the sensorium is tested by static tests of speed of vision, and the important element of speed is entirely left out in all other types of ocular test. The incompleteness and lack of special fitness of the usual clinical and ophthalmological tests for this purpose should be obvious without further elaboration.*

In the early years of aviation, particularly during the World War, the need for testing the fitness of pilots for flying was duly recognised. In later years, however, the importance of testing pilot fitness was overshadowed by the development of instruments and the stress laid upon them as a guide for flying. In this a grave mistake may have been made. Recently there seems to be a growing conviction that the pilot is an important factor in the increasing number of airplane crashes. There is perhaps a good reason for this conviction. It may be that with the rapid improvement in facilities for aviation, the attitude of the pilot has changed with respect to the importance of his own qualifications, fitness and training and to the highly specialised nature of the services he was formerly called on to contribute and still has to contribute

* In connection with the testing of fitness for any work or performance it may be of interest to point out that where there is a composite test involving several functions, it is usually considered both the logical and a time-saving procedure to make that test the initial test and to make separate tests of the individual functions only when the composite test shows a deficiency or when individual tests are deemed advisable for other reasons. It is our experience that an adequate test of dynamic speed of vision is a very sensitive means of separating out those who have ocular and oculomotor deficiencies. Further, it measures directly the importance of these deficiencies in terms of the performance that has to be accomplished, namely the quick and accurate seeing of objects in different directions and at different distances. No amount of testing separate and individual functions can possibly do more than serve as a basis for estimating a candidate's ability to accomplish this performance. The testing of the separate functions would seem logically to be a later step in order to find out what function was at fault and what, if anything, could be done to correct the deficiency.

A well-known analogy is the visual acuity test as a test of fitness. The customary procedure is to give the composite test first and then if a deficiency is found to follow this up with tests of the component functions—the power to form correct images (refractive) and the power of sensory discrimination. In the selection of candidates as to fitness by the visual acuity test it is scarcely deemed necessary or expedient to perform the analytical tests unless a deficiency is shown by the composite test; nor could an accurate estimate of acuity of vision be made from the results of the analytical tests, refractive and sensory. Would it not seem to be equally exceptional to try to arrive at a rating of the ability to use the eyes for the quick and accurate seeing of objects in different directions and at different distances from any amount or kind of testing of the separate functions involved, ocular and oculomotor? That this should ever have been attempted is probably due to the lack of an adequate composite test.

in emergencies.* It may be also that not enough attention is paid to fitness in the selection of pilots and to making sure that they are in fit condition for service at all times when they are called on to render service. It seems strange that the plane should be carefully tested on every point of its construction and operation before each flight and little or no attention given to the pilot at that important time other than to see that he is on hand to fly. With the advance in scientific and mechanised control, the importance of the human factor has without question been thrust into the background.

Our first model of the tachistoscope, devised during the World War as stated earlier, was used at Mineola for studying the fitness of entrance candidates and later was taken to France by Dr. William Holland Wilmer, surgeon in charge of the Medical Research Laboratories, Air Service, A.E.F., for the purpose of studying the fitness of aviators already in the service for the various tasks required of them, particularly in combat flying. Since the war the instrument has been greatly improved and is now being manufactured by the Gaertner Scientific Corporation. As manufactured by this company the instrument has been still further improved. One of the earlier improved models was described in the Archives of Ophthalmology.[3] In 1933-36 this model of this instrument was used by Comdr. C. J. Robertson (MC) U.S. Navy, for the study of fitness for aviation on such points as entrance requirements, disqualification for the service on account of age, fatigue in relation to number of hours in the air, individual susceptibility of fatigue, etc. Dr. Robertson has published his results in a series of articles in the U.S. Naval Medical Bulletin and the Archives of Ophthalmology.[4]

The instrument provides a test which is without doubt one of the most sensitive that has ever been devised for the detection of any imperfection in the oculomotor, accommodative or sensory functions or of any temporal disturbance in these functions. Common causes of these disturbances are fatigue, loss of sleep, worry and all mental states which distract attention, the variations in physical and mental efficiency and alertness common to every one in the course of time, illness, etc. Any of these may be sufficient to cause the aviator to fail or falter at a critical time in the high degree of service that is required of him. The profound effect of fatigue and other disturbances of bodily and mental

* In this connection it must be remembered too that the use of a greater number and complication of instruments has in itself become an ocular problem. The quick and accurate reading of instruments in addition to the quick seeing of objects outside the plane indeed constitutes an important requirement for speed in the use of the eyes and an important need for testing for age as a disqualifying factor. As a test instrument for all such needs and requirements, the tachistoscope described is admirably fitted.

efficiency on such highly organised and delicate muscular co-ordinations as are required in the speedy use of the eyes, is well recognised. Fatigue, for example, has to be tested through its effect on some function. Perhaps no more delicate means can be found for detecting fatigue than through its effect on speed in those uses of the eyes which require highly co-ordinated changes in muscular adjustment. The delicacy and accuracy of co-ordination that are required in these adjustments will be realised when one remembers that changes in the convergence of the eyes are made by six pairs of muscles which serve to support as well as to move the eyes, and that the breadth of the images on the two retinae which must be combined into one in seeing is, for the standard test-object, of the order of thousandths of a millimetre. Also in changing the vision from near to far and back again to near, the muscles of accommodation must act in perfect co-ordination with the muscles that move the eyes. Still further, the sensorium must function at a high level of efficiency.

In testing programmes the point which seems thus far to have been most frequently if not entirely overlooked is the importance of temporal disturbances in fitness, particularly in relation to the prevention of accidents. While it is true that a human being cannot be treated as a machine, we do know that the aviator is subject to many disturbances from day to day that render him unfit for those services which require a supernormal fitness and proficiency and involve a responsibility for human life and safety. It seems only reasonable, therefore, that the fitness of the aviator should be tested before each flight, at least before each more exacting flight is undertaken, as well as the fitness of the plane which he operates. It is surely not enough to require only an entrance test of fitness and then allow him to go on without further check, even without regulation of his conditions of living, until age or some mishap retires him from service.*

Our personal feeling is that a test should be made of each aviator immediately before and after each flight. We have the following reasons to offer for this:

(*a*) The test before the flight should be used to prevent the

* We understand that some improvement in this respect has already been made or is in contemplation. The following, for example, is quoted from the article by Major-General Fechet referred to earlier in the paper: "Striving to promote continued pilot fitness, we developed a new profession in the Army—that of Flight Surgeon. He has paid us handsome dividends. We found that annual or semi-annual examinations were not enough. We needed a smart medico to keep the pilots under daily observation . . . . Flight Surgeons paid off in reducing airplane crashes. I commend that thought to commercial airline operators." He says further: "Health is mental as well as physical. I think the mental side plays a bigger rôle in air pilot health than the physical. A man who is worried and preoccupied about domestic discord or financial extremities may be more unsafe than one subject to fits or fainting spells."

aviator from going into the air when he is clearly and dangerously unfit for service. It is neither fair nor good public policy that a knowledge of his fitness should depend upon his own report. In combat flying in particular he might well be prevented from making such a report through fear of being called a slacker or because of patriotism or personal pride. In commercial service, too, many reasons might operate to deter him from making a report of unfitness. The responsibility for making such report should be taken out of his hands and consigned to a competent examiner. A surgeon, however long his experience and however well demonstrated his ability, voluntarily subjects himself to a test of steadiness of hand and keenness of eye before undertaking a critical operation. Surely in these offices requiring services equally responsible for life and safety, there should be some test of fitness immediately before the service is undertaken. Such precautions might be considered extreme had not the frequency of airplane crashes demonstrated that something is radically wrong in modern aviation.

(*b*) The test at the end of the flight would indicate how well the aviator has stood the strain of his service. It would give valuable information as to his susceptibility to fatigue and make it possible to assign him to the length and kind of service he is capable of performing. It would also give a great deal of valuable general information as to the number of hours in the air and the amount of strain which aviators, taken collectively, can reasonably be expected to stand.

(*c*) From the results of the tests, graphs or curves can be plotted which will give a splendid picture of the aviator's fitness, his endurance, his susceptibility to fatigue, the consistency of his service, etc. In short, these records would serve as the basis for a high type of personnel service in aviation. From these graphs it can also be readily seen when the aviator is becoming incapacitated for service through age or some other cause. This alone should be sufficient reason for adopting some such programme.

(*d*) A feasible test and instrument are available. The test does not require more than ten minutes to perform and the result can readily be given a numerical rating. The instrument is easy and convenient to operate and the entire programme well within the technical capabilities of the average flight surgeon.

Two forms of the test may be suggested: (1) The time required for the discrimination of the object at near, the change to far and back again to near may be measured in each test; or (2) in a series of preliminary tests the median or average times required for these performances may be determined for each aviator and these be taken as his standard of performance. In the routine procedure of

testing, the instrument should be set to give these times of exposure. The test may consist of ten or some suitable number of trials to ascertain in what percentage of cases the aviator can attain his standard of performance. This percentage may be accepted as the index of his fitness at that time.

3. *A specific performance test of fitness for night flying.*—As a part of the routine of night flying, the pilot must look back and forth from the comparatively highly illuminated cockpit and instrument panel to more distant outside objects under very low illumination. The ability to do this quickly and with a satisfactory discrimination of detail is perhaps the most important visual qualification of a night pilot. It involves a change in the adjustment of the eyes for both intensity of light and distance of object. The night flyer has quickly to adapt from light to dark and back again to light as well as at the same time change his adjustment for distance from near to far and back again to near. The time required for this combined action in a suitable test relationship can be measured with the instrument described in this paper. All that is required to make the additional measurement of speed of adjustment for change of intensity of light is obviously to illuminate the two near test-objects to an intensity different from that of the far test-object. The near test-objects, for example, could be given an intensity similar to that illuminating the cockpit and instrument panel, and the far test-object any suitable low intensity, preferably that approximating the outside illumination at night. To make this test the instrument should be installed in a dark or darkened room. A small curtained enclosure should be provided the back wall of which is the face of the instrument. The enclosure will simulate the cockpit and will be illuminated to an intensity suitable for a cockpit. In this the examinee will sit. The face of the instrument will, then, have the illumination of the cockpit, which illumination should also be given to the near test-objects. The far-test object as seen in the mirror should receive the low amount of light that is selected as representing that of objects outside the cockpit. The test will then be performed in the usual manner. The time will be measured to discriminate the near test-object and to change the adjustment from the near to the far test-object and back again to the near, both with respect to adaptation and muscle control. For this test a much larger far test-object will have to be used than is employed for measuring speed of adjustment for distance alone under medium intensities of light. In this respect it may be noted (*a*) that small objects could not be seen with the intensity of illumination and time of exposure that are provided, (*b*) that the objects which the night pilot is required to discriminate outside the cockpit are in the main large objects and (*c*) that the time in which he has to make the discrimination is usually short.

It may be noted further that the test situation presented by the instrument is extremely favourable for the control of the preliminary adaptation of the eyes. That is, the observer is seated facing the exposure shutters and the front panel of the instrument which receive the same intensity of light as falls on the near test-objects.* Thus in the natural course of the experiment he can very easily and conveniently be adapted for any length of time that is desired to the same intensity of light at which the experiment begins and ends—namely, the intensity usually found in the cockpit and on the instrument panel. The near test-objects could of course be given any value of illumination that is wanted, also the far test-object; that is, any experiments or series of experiments involving differences in the intensity of illumination of the near and far test-objects over a wide range could be performed. Since in the instrument described, the total exposure-time may be varied in continuous series up to 10 sec. or longer, the range of exposure-times provided is ample for the purpose.

Obviously the test can be made in three ways: (*a*) The maximum performance for each person may be determined. This would be the analogue of making tests of visual acuity, for example, in terms of the minimum visual angle that can be discriminated. This procedure is the longest because it requires a correct adjustment of the exposure-times for each observer, but it results in a much finer grading of performance. (*b*) Any suitable number of levels of performance may be chosen and the instrument set at once to give these levels. This method of testing would place persons in ranks or groups and is the analogue of the Snellen method of grading visual acuity. It is a quicker procedure than (*a*) but the grading is correspondingly rough. By a practised examiner, testing by this method should take but a few minutes. In forming such a graded scale in our preliminary work with the instrument in general,[2] we used steps of 0·02 sec. for the double excursion. These intervals have been found very suitable by Comdr. Robertson in his work with the instrument in classifying aviators as to fitness of performance for day flying.[4] An alternate procedure would be to determine directly specific scales made up of the number and breadth of steps needed for the purpose in question. (*c*) Critical or limiting values could be established for any purpose for which such values are desired. The instrument could then be set for these values after the usual preliminary trials to familiarise the examinee with the test, and the determination made whether he could give the judgments required, which could be done with a single setting of the dials of the instrument.

* A convenient means of illuminating the exposure shutters and the front panel of the instrument and of varying the intensity of illumination over a wide range as may be desired, is the device we have called a variable illuminator.[5]

The above-mentioned three procedures are for a given intensity of light and given distances of the near and far test-objects. The test can be varied indefinitely by changing these intensities and distances.

In this test we have not only a scientific test of capacity, within the limits considered, but a specific performance test made under scientific conditions with accurate scientific controls. We call this a specific performance test because the actual visual task which the pilot has to perform in night flying is very closely copied. Speed of adjustment for change of distance of object and change of intensity of light is accurately measured—that for change of intensity of light (speed of adaptation) much more accurately, within the limits of the instrument, than is possible for example with any adaptometer that has yet been devised.

4. *A test of disturbance in fitness due to altitude.*—The instrument would seem to provide a very sensitive means of detecting and studying the effect of altitude, temperature and other variations in the physical conditions to which the aviator is subjected. In testing for the effect of altitude the test should be made when the plane is at the altitude in question, not after it has landed. The compactness of the instrument renders it admirably fitted for making tests on the plane. The instrument should be suitable too for studying the effect of oxygen deficiency and of changes in air pressure wherever these occur or may be produced, also equally suitable for testing individual differences in susceptibility to these effects as a part of the programme for testing fitness. Further, aviation is not the only vocation in which a prior knowledge of the individual's characteristic fitness in these respects would be of value.

As further evidence of the sensitivity and versatility of the instrument it may be noted that while an older model was in use at the U.S. Naval Station, at Pensacola, Florida, it was found that the results were affected by alcohol, tobacco and coffee, and that the unusually high speeds for the different age groups were obtained from those who abstained from the use of tobacco.[6]

5. *A limiting test for age as a factor in fitness.*—As the eyes grow older the importance of accommodation in a dynamic test for speed of vision increases until it becomes the dominant factor in the result. Speed of accommodation is not an important factor in the results for the young eye unless there is some accommodative abnormality. Accommodation is the first of the ocular functions to deteriorate with age and the one that shows the closest correlation with age. The earliest manifestation of what would ordinarily be called a deterioration in this function, that is, a deterioration of significant practical importance, is, so far as

measurements have been made, a decrease in speed. A comparative test of dynamic speed of vision of the eyes of the young and those of the middle-aged and near middle-aged furnishes striking and most conclusive evidence that the latter are under a special handicap in regard to all types of work that require speeds that are normal or supernormal for young eyes. For example, many automobile drivers in an early stage of presbyopia have advised us that they dare not take their eyes off the road for the length of time they require even to read the speedometer. Driving under conditions which do not permit of the inspection of the instrument panel is, it will be granted, somewhat hazardous.

There is also, of course, an important need for a limiting test for age in aviation. The aviator in combat flying and in landing, particularly on water, needs everything that can be had in the way of dynamic speed of vision. In the early days of aviation —for example, during the World War—such a test was not so greatly needed as now. The vocation was new and by far the greater number of aspirants were young men. Now the aviators of that time, such as have survived, have grown older. It is difficult to make them realise that they may no longer be fit for the service or all branches of it and hard, without definite and concrete evidence of unfitness, to make a case against them that will stand.

The chief value of the test as a limiting test for age is in its application to persons between the years of 30 and 45 or 50, the period for which a precise and sensitive test is most needed and most difficult to obtain.

6. *A means of measuring ocular fatigue and recovery, of testing individual susceptibility to fatigue and capacity to recover, and of detecting disturbances in fitness from other causes such as loss of sleep, worry and all mental states that distract attention, etc.*—The addition of speed or power to sustain, to any test performance gives greater sensitivity for the detection of fatigue. For example, in a study of ocular and oculomotor fatigue, the test of dynamic speed of vision can be made at suitable intervals during the performance of a task, and from the results a curve for fatigue can be plotted for each person tested. From these curves individual susceptibility to fatigue of persons in the same age group and of those in different age groups can be compared. There are great individual differences in this susceptibility which, it scarcely needs to be pointed out, is an important factor to be considered in determining ocular fitness for any type of work, especially for all performances requiring a high degree of fitness. Age, moreover, is a most important factor in this susceptibility. One would expect, therefore, that using the test of dynamic speed

of vision as a fatigue test would be a most sensitive way of determining the effects of age on ocular fitness.

In addition to determining ocular fitness and susceptibility to ocular fatigue, the instrument and test may be used for testing the rate of recovery from ocular fatigue. From a study of the curves for ocular fatigue and recovery, persons of the same age group and those of different age groups can be compared as to susceptibility to ocular fatigue and the capacity to recover. A greater difference due to age might be expected for the latter than for the former. Our experience and observation is that while older persons become fatigued more easily, the especially marked handicap of age is on the side of recovery.

An instrument that furnishes a means of measuring and making a quantitative comparison of both ocular fatigue and recovery, in addition to measuring speed of performance, should have both important scientific interest and a practical utility over a wide range. Such a means would be of value not only in the selection of persons in all vocations in which special ocular fitness is required but in checking up on the persons selected for their ocular fitness at any time to accomplish an assigned task. A record of the dynamic speed of vision and the rate of ocular fatigue and recovery for any person gives a comprehensive estimate of his ocular fitness. In addition to the particular service rendered, studies comprising such determinations give information of general value.

In connection with the discussion of ocular fatigue and recovery it should be borne in mind that oculomotor fatigue and depression sustain a general relationship to general bodily fatigue. This relationship is sufficiently close to suggest that a fairly comprehensive estimate may be had of the bodily condition by testing the combined ocular and oculomotor performance. Just how much work has been done in direct confirmation of this sympathetic relationship we are not prepared at this time to state. We may, however, make two citations at this time. Comdr. Robertson has used our test and instrument with success in determining and studying fatigue in aviators. Among other things he was able to compare quite easily the amounts of fatigue induced by 1, 2, 3 and 4 hours of flying.[7] The second citation refers to experiments recently made in Russia, where a great deal of interest is being taken in physiological optics of the practical type we have been trying to develop. These experiments were conducted by J. J. Troumpaitz in the Laboratory for Lighting Research at the Leningrad Institute for Industrial Hygiene and Accident Prevention. The test of the ocular condition used was one devised by us for studying the effect of lighting conditions on ocular fatigue

by measuring the eyes' power to sustain clear seeing for a period of time.[8] Bodily fatigue was induced by the operation of a device called a bicycle-ergograph, which was selected for the study because its operation required no fatiguing use of the eyes. Nevertheless, a close relationship was shown to exist between bodily fatigue as measured by the ergograph and ocular fatigue as measured by the test of power to sustain clear seeing.*

Also, as indicated in the heading of this section, the test for dynamic speed of vision can be used very effectively to detect disturbances in fitness due to other causes such as loss of sleep, worry and all mental states which distract attention, the variations in physical and mental efficiency and alertness common to every one in the course of time, illness, etc. This use of the test has been sufficiently discussed under the heading " A test of pilot fitness for aviation."

7. *As a means of training eyes to greater oculomotor and accommodative facility.*—The discussion should not perhaps be brought to a close without noting the possibility of using the instrument as a means of training oculomotor and accommodative facility. Its daily use for a suitable length of time might very well serve to raise eyes slightly or moderately subnormal to normal proficiency and normal eyes to a needed supernormal proficiency. Under the spur of a speed requirement it would seem that the co-ordination of so many individual performances might be facilitated to a significant amount by daily practice. We suggest this possibility of the benefit of a prolonged systematic use of the instrument as a means of training the eyes, particularly eyes with slight muscle defects, in spite of the fact that a minimum of practice effect is shown by normal eyes in the ordinary use of the instrument for making a test.

Summary

With the growing conviction that the pilot is an important factor in the increasing number of airplane crashes, it seems that more attention should be paid to fitness in the selection of pilots and to making sure that they are fit for service at all times when they are called upon to render service. It is strange indeed that so much care is taken to see that the plane is in perfect condition before a flight is undertaken and so little attention is given to the condition of the pilot. While it is true that a human being cannot be treated as a machine, we do know that he is subject to many disturbances from day to day that render him unfit for those

* From a report of work submitted personally to the authors by J. J. Troumpaitz. The purpose of the experiment was to show the loss of efficiency which the eyes sustained during a period of heavy physical work.

services which require a supernormal fitness and proficiency and involve a responsibility for human life and safety. These disturbances can be shown by test.

In the paper very sensitive tests of fitness and disturbances in fitness are proposed and a convenient instrument for giving these tests is briefly described. This instrument is an electrical multiple-exposure tachistoscope comprising a timing mechanism and three shutters electrically operated, so arranged as to expose in immediate succession a near test-object on the left, a far test-object in the median plane and a near test-object on the right. The test-objects are the letter E which can be rotated into four different positions to give an objective check on the judgment. The far test-object is mounted in the same cabinet which contains the near test-objects, the shutters and the timing mechanism. A front surfaced mirror which is mounted at an appropriate distance from the rear of the cabinet serves to reflect into the viewing slit the image of the far test-object, thus reducing floor space requirements. The distance of the far test-object, the lateral separation of the two near test-objects and the illumination of all three can be varied at will. The exposure-time of each of the shutters is controlled through the setting of the appropriate pointers of the timing dial. The total of all the exposures can be varied from 2 to 10 sec. At these limiting ranges the divisions on the dial equal respectively ·004 and ·02 sec. If still longer exposure-times should be required, this can be arranged for in the reduction gearing of the motor operating the timing mechanism.

In designing the instrument special attention has been given to compactness of construction, ease of operation and ready portability.

The instrument makes possible: (*a*) the use of a set of very sensitive tests which take into account as no other tests do, both the motor and the sensory functions of the eyes in just the proportion that they occur in the act of seeing objects in different directions and at different distances, (*b*) the testing of the dynamic speed of vision with either the oculomotor or the accommodative feature emphasised and (*c*) the measurement of the time required to change from near to far and from far to near in combination or separately.

The following practical uses of the instrument and test procedure are discussed: (1) a test of vocational fitness in all cases in which dynamic speed of vision is an important requirement; (2) a test of pilot fitness for aviation; (3) a specific performance test of fitness for night flying; (4) a test of disturbance in fitness due to altitude; (5) a limiting test for age as a factor in fitness; (6) a means of measuring ocular fatigue and recovery, of testing

individual susceptibility to fatigue and capacity to recover, and of detecting disturbances in fitness from other causes such as loss of sleep, worry and all mental states that distract attention, etc.; and (7) as a means of training eyes to greater oculomotor and accommodative facility.

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RARE OCULAR DEVELOPMENTAL ANOMALIES IN ASSOCIATION WITH CONGENITAL AND ACQUIRED BLINDNESS

Clinical "proof" of vitreous development

BY

J. HORTON YOUNG

CHELMSFORD

THE following history of a blind patient who attended my ophthalmic clinic illustrates the complexities which underlie certain types of cases presenting themselves for blindness certification.

In this case there had been an " arrest " of development of certain structures within the left globe. This eye was congenitally blind. The right eye was remarkable for the complex factors which ultimately caused the eye to become blind and for the fact that the same agency was responsible for the ultimate death of the patient.

Present History and Course.—The patient H. W., born January 3, 1918, attended my clinic on December 12, 1939, and subsequently for certification under the Blind Persons Act. He was totally blind. The right eye became blind three years previously following a severe attack of pain and inflammation in this eye. As the fundus was not seen and the eye presented the appearance of posterior synechiae with gross generalised enlargement of the globe a provisional diagnosis of uveitis, complicated by secondary glaucoma, was made. The *left* eye was congenitally blind and exhibited developmental anomalies which in view of their importance I proceeded to record " in minutiae."

At the same time the patient's family history was investigated in an endeavour to find an hereditary basis for these anomalies.

The right eye necessitated removal and this was advised. Shortly afterwards the patient was admitted to the Old Church

Genealogy.

= Bilateral Blindness: Congenital.

= Normal.

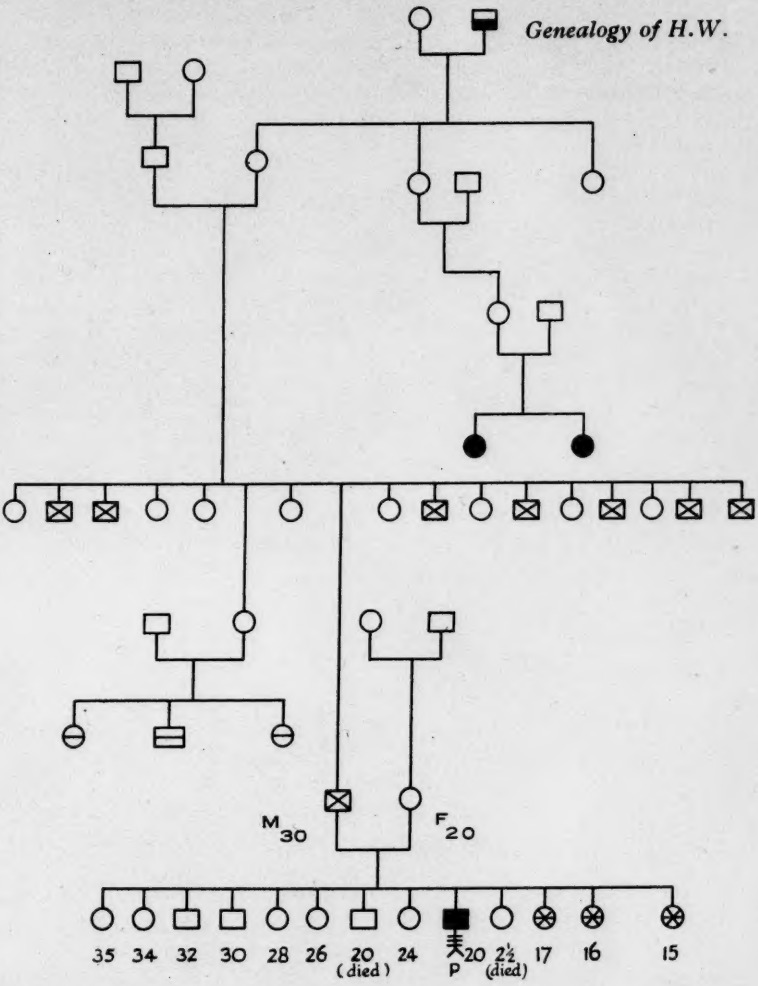
= Severe Myopia.

= Myopia and Mental Deficiency of Congenital origin.

= Patient, Congenital and Acquired Blindness.

= Mental Deficiency.

= Unilateral Blindness: Cause Unknown.



Hospital, Romford, where the operation was performed under evipan anaesthesia. Subsequently the patient developed aphasia, a rise in temperature, rash on the body, right hemiplegia, and cerebral embolism, dying 14 days later. A post-mortem examination was made to establish the cause of death.

Previous History, Illnesses, etc.—Birth quite normal, no history of trauma, difficulty or forceps. Six years ago developed a keratitis which necessitated carbolisation. Four years ago had

a dental operation under G.A. which was followed by aphasia which cleared up without any trouble. The patient was discharged as healthy.

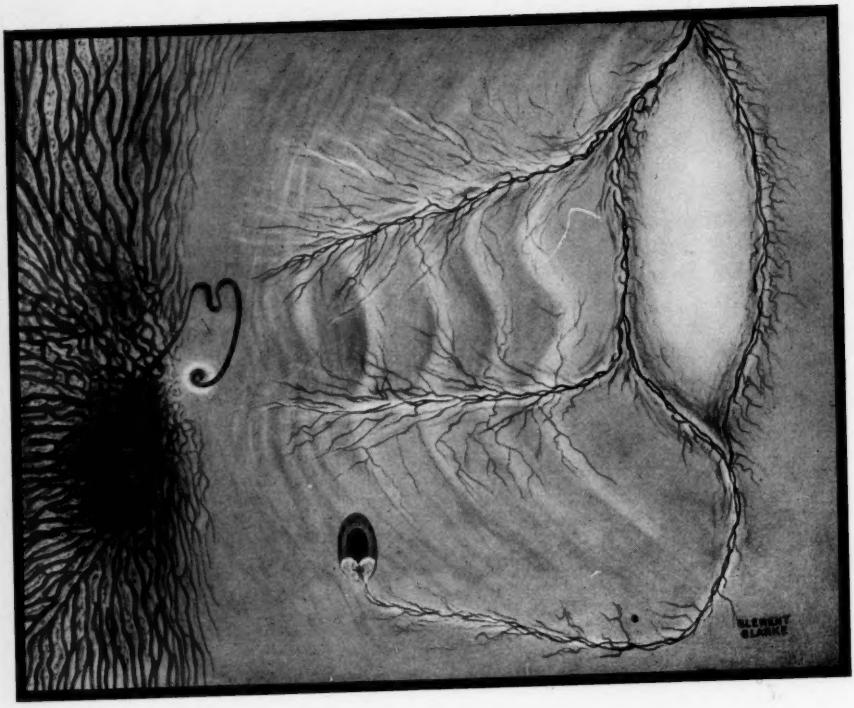
There was no history of rheumatism. The right eye became suddenly blind one year later (three years ago), following a severe attack of inflammation in it. Following this the right eye had enlarged slowly at first, but during the last eighteen months it had grown rapidly in size.

This is best studied from the schematic diagram. I have endeavoured to make this as accurate as possible, but the prevailing circumstances (family attitude) were against individual interrogation.

It will be noted that there is an extensive history of severe myopia in this family. Mental deficiency of congenital origin (poor cerebral development) is to be found in a number of cases. Bilateral blindness of " congenital " origin was present in two children on one side of the family. The blindness in one instance being given as " ganglio-neuroma " and in the other due to severe myopia.

General Appearance, etc.—Patient stands well erect, head turned to the left side, somewhat undersized in stature, physical age 15 to 16 years (actual age 20 years), slight pallor of the face, head squarish, but no obvious bossing, facial asymmetry present with the left orbit and globe lower than the right. Palpation of the left orbital margin showed that it appeared to be more spherical than the right orbit. This may have been due to the position of the left eye which had assumed a " normal " position of divergency, being a congenitally blind eye. The teeth were irregular, some peg-like, but no evidence of Hutchinson's teeth. There was no suggestion of a defective bridge or rhagades. The arms were long in proportion to the body, muscles were firm and strong, and the hands and feet were on the large side. Dyspnoea, tachycardia, club fingers or other signs of congenital abnormality apart from the condition of the left eye were absent. (See also post-mortem findings.)

Ocular findings.—In view of its importance the left eye will be discussed first. Congenitally blind. No P.L. Tension normal. The anterior chamber was normal in depth (as judged by the rudimentary iris position), and was filled with vitreous. The anterior and posterior chambers were in direct communication as there was luxation (ectopia vera) of the lens. The vitreous gel was solid and perfectly transparent. There were no floaters. The optical and physical perfection of the vitreous was heightened by the partial aniridia and the malposition of the lens. The rudimentary iris was represented by a small ring of tissue one and a



UNIV. OF MICH.

DISEASE

Inoculation of Right Eye

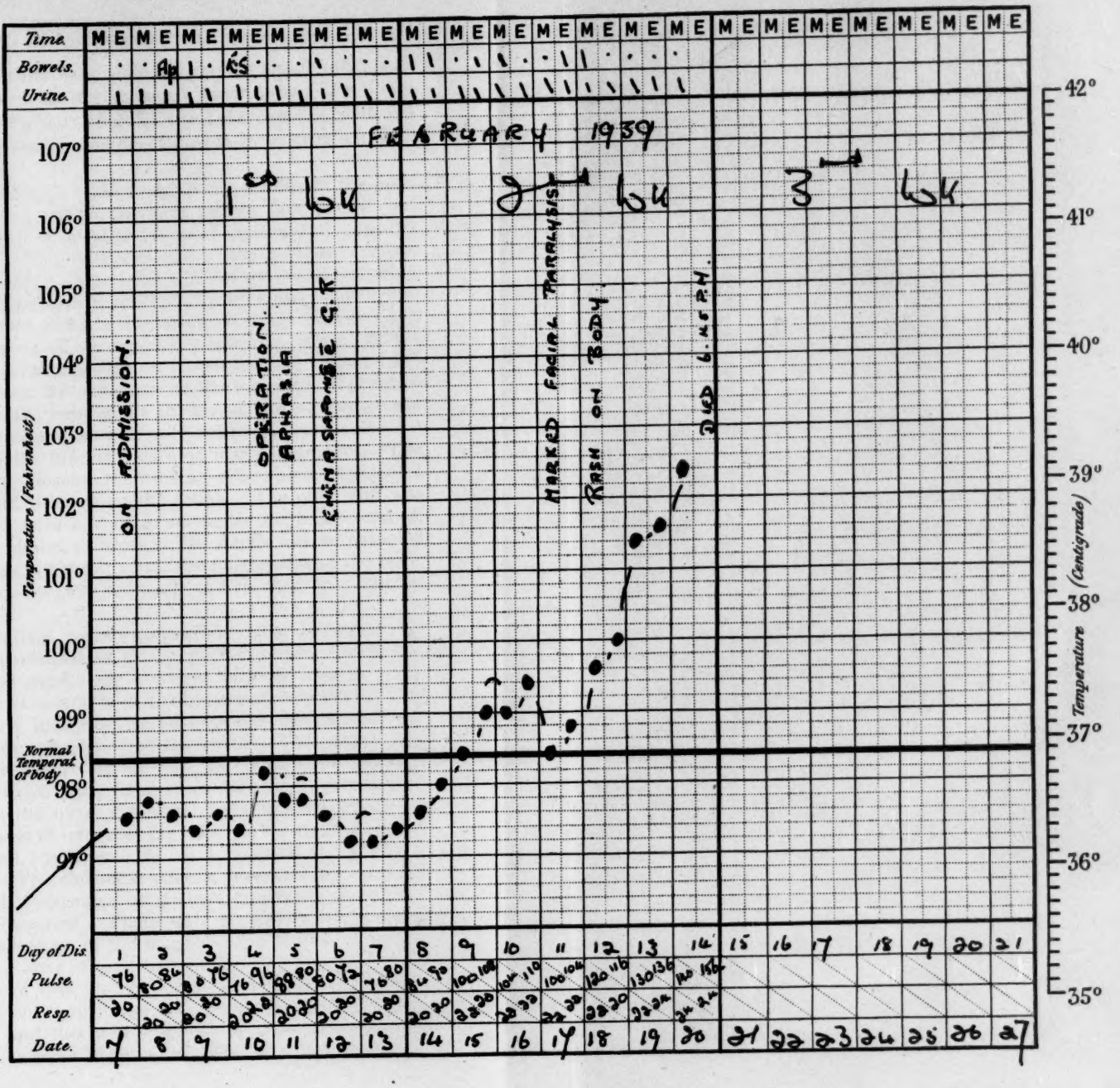
Case Book N° 26.

Name [redacted]

Age 21 yrs 2 mos.

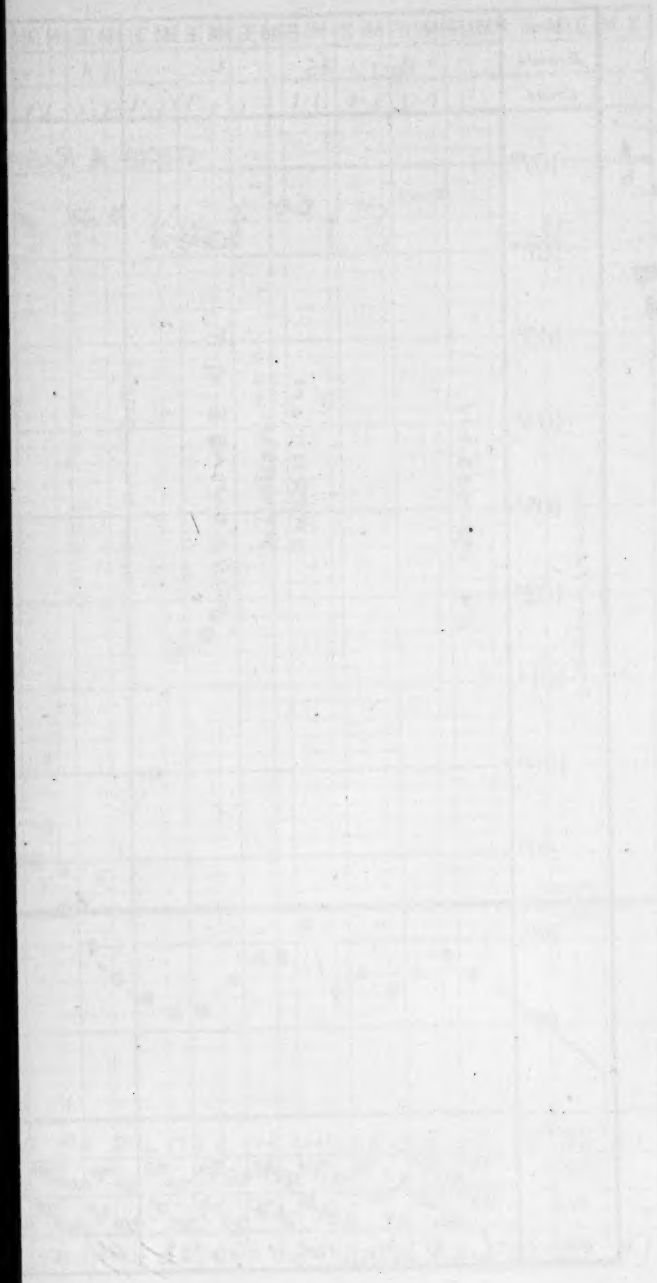
Diet

Notes of Case



Date of admission 7. 2. 39.

Result



half mms. wide attached to a zone of greyish tissue—the rudimentary ciliary body—running circularly around the globe. It is highly probable that the pars reticularis and the canal of Schlemm had also suffered a similar maldevelopment in association with these two structures.

The lens was abnormally placed within the fundus in the post-infero-temporal region, which, in view of the fact that it was notched and possessed a peculiar physical structure, I consider was a true ectopia. This lens was much smaller than normal, notched, sphero-conoid in shape with a dorsal groove terminating anteriorly in a kidney-shaped base which was of a furry matt-white colour. From the lens notch a fine leash of blood vessels made their way to the region of the equator where they made contact with another vessel about a peripheral retino-dialysis. Apart from the kidney-shaped base the remainder of the lens capsule (a small part only could be seen) possessed a thickened, dirty-grey, greasy parchment appearance and seemed only relatively translucent.

The remainder of the fundus presented many anomalies. The optic nerve head was absent, there being a complete absence of nerve fibres here and throughout the retina. The optic cup was of extremely narrow bore and of great depth (no base could be seen) and lacked a lamina cribrosa. The depth was accentuated by the sharp-cut edges of the cup and the narrowness of the bore. The position of the disc was more up and in than in a normal globe.

There were no retinal vessels proceeding from the optic cup and segmentally distributed as in the normal retina, which was completely avascular except for a single flattened vessel. This blood vessel was arterio-venous in colour, completely devoid of a glial covering which indicated its adventitious nature and was not developed in normal relation to the retina. This ribbon-like vessel rose from the depths of the cup, ascended some distance into the vitreous, curled upon itself twice and then descended to the retinal level on the nasal side and, dividing dichotomously, ended in an oval mass of irregular pigment. This pigment had a burnished gun-metal appearance which I mistook at first for a primitive tapetum. The choroidal vessels, however, were hidden over this mass and it appeared as if there had been an attempt at normal retinal formation. There were no white, patchy spots and there was no evidence in the neighbouring choroidal vessels that this had been a zone of past choroiditis.

The significance of this pigment was very obvious since this nasal area was the only portion of the fundus which had a suggestion of choroid and this was of primitive type showing only large vessels, a complete absence of choriocapillaris and the

medium-sized vessels. Apart from the zone of pigment aggregate, the pigment distribution was of a fine, very scattered type (sand grains). The retina on the temporal side was avascular also, and here there was an absence of choroid and pigment of any kind. There had been no differentiation of a macular zone. I tried hard to find evidence of a past or present retinal circulation, which I thought might exhibit themselves in the form of attenuated fibrous lines, as I wanted to be quite sure that the phenomenon of this avascularity was not that of a secondary functional atrophy. This point was of importance since the retina was detached on this temporal side in association with a retino-dialysis of an unusual type. The phenomena observed in relation to this detachment are worthy of special mention and I shall describe them in detail.

The detached retina in this area consisted of two large, radiating folds spreading fan-wise from the region *near* the disc, both crests running out to the dialysis, through which the vitreous had " herniated " (or differentiated) without disturbance of its transparency. Commencing from a zone somewhat anterior to the equator, a fine leash of supporting stroma passed down towards the dialysis and divided into two columns, one column passing along the free edge of the dialysis, but jumping from crest to crest, leaving the trough, between the two main folds, untouched. This supporting stroma carried very fine vessels to the underlying retina. The stroma continued its path vertically downwards to rejoin the other branch of fibrous tissue which followed the course of that portion of the peripheral retina which had remained attached to the " ora serrata," which was of a grey colour. Where the supporting stroma touched the crests, fine bundles of fibrous tissue passed down the folds, accompanied by fine blood vessels, to the troughs, thus giving the two retinal folds the appearance of fine veined leaves. The dialysis was so large that it was possible to look between the pillars of supporting stroma and through the dialysis, and view the matt-white sclera, which was completely devoid of any sign of past or present blood vessels. The effect of looking through these pillars into this post-retinal " cavern " with my luminous ophthalmoscope, was like looking into a lighted fairy grotto, so beautiful was the play of colours between the faint, lake-green retina, the faint pearly-blue iridescence of the supporting stroma with its accompanying fine reddish blood vessels, and the brilliant matt-white sclera. The whole effect, reinforced by the heightened reflexes, was quite unlike anything I had ever seen before. With regard to the radiating retinal folds, these were " ironed out " and lacked the cross-dimpling seen in ordinary dialysis. (The analogy would be

the creases in one's sleeve on flexing the elbow.) It appeared that the retino-dialysis was the direct result of slow contracture of the supporting stroma. Probably also the effect may have been contributed to by the absence of the normal retinal vessels, with their attendant elastic tissue, and in part to the thinned retina which lacked neuronal development.

Discussion

In a congenitally blind eye of this type in which there are unusual developmental anomalies there must exist clues which point to the mode of development of some of the structures in the normal eye. The following is a brief summary of the extraordinary clinical phenomena observed in this eye.

(1) Primitive optic " disc "—absence of nerve head—no lamina cribrosa—narrow-bore optic cup, great depth.

(2) Complete absence of the normal retinal vascular system in the *non*-detached and the *detached* portions of the retina and the optic cup—complete absence of neuronal development.

(3) Partial achoroidia temporal side and a maldeveloped choroid nasal side in association with which there was pigment deposition of unusual type.

(4) Rudimentary ciliary body (grey colour due to absence of pigment epithelium, normally developed from the neural ectoderm).

(5) Partial aniridia.

(6) Luxatio lentis (probable ectopia vera), associated with abnormal physical shape and structure with an auxiliary blood supply.

(7) A perfect vitreous.

(8) No evidence of any remains of the primitive hyaloid vascular system. (This negative evidence is valuable since retinal circulation is an outgrowth from this primitive system of vessels.)

Embryological Interpretation.—I shall deal first with the primitive tissue layers and their relation to the above developmental anomalies.

An analysis of the above facts shows that it was those elements within the globe, requiring a special cellular differentiation and the nutritional elements, which were involved in this " arrest " of development.

It will be seen that only those structures derived from certain primary tissues, etc., viz., neural ectoderm, adhesions between

surface and the neural ectoderm, and the associated paraxial mesoderm were affected.

Neural Ectoderm.—Of all the structures derived from this tissue only the original lining of the optic cup was to be seen, and this in its most primitive state since it never reached the stage of neuronal differentiation (17 mms. embryo stage).

Adhesions between the neural ectoderm and surface tissues.—Two structures are derived from this, the vitreous and the suspensory ligament. As previously stated, the vitreous was perfect and it would seem that the suspensory ligament must have either a different derivation from that postulated above, or that this " secondary " vitreous is the basic structure on which is superimposed the " self-determining element," to differentiate "tertiary" vitreous, which is one of the outstanding characteristics of the embryonic ocular tissue.

Associated Paraxial Mesoderm.—Of all the structures derived from this layer, only the most cellular and nutritional elements were absent. These included ciliary muscle, retinal circulation, greater part of the uveal system of vessels, certain orbital vessels which take part in forming the uveal system of vessels and probably the structures in the " angle " of the anterior chamber.

Considering the above developmental anomalies in this left eye, which involved the higher-specialised elements, it is rather wonderful that the " self-determination " of this ocular tissue resulted in an eye at all. It is quite obvious that the mode of development of ocular tissue is not dependent on the association of one tissue with another. The essential factor appears to be the inherent biological determination of individual cell units, reinforced by some local stimulus.

A deductive reasoning to provide clinical " proof " of the origin and development of the vitreous.

The absence of the following structures, viz.:

(1) Ciliary body,

(2) Normal retinal circulation,

indicated that they took no part in the development of the perfect vitreous, A.

We have also seen that retinal differentiation did not proceed beyond the 17 mms. stage, if it ever reached this stage (1).

The absence of choroid on one side and the undeveloped choroid on the other side, dates the time of the " arrest " of development to the 5 to 6 mms. stage of embryonic development (2).

The hyaloid system of vessels begins to develop about this time (3 to 5 mms. embryo) and in view of the absence of any " remains " of this system of vessels in this primitive eye, the

non-development of the normal retinal vascular system (an outgrowth from this primitive system) and in the presence of factors (1) and (2) we may say with confidence that this hyaloid system of vessels never developed at all (3).

It follows, therefore, that the vascularisation of the " primary " vitreous is not an essential precursor of adult " secondary " vitreous. B.

We cannot say that in the absence of the hyaloid system of vessels the " primary " vitreous is *not* identical with the " secondary " vitreous (4).

The lens has been shown to be of a primitive type, possessing an auxiliary blood supply and situated in an abnormal position.

It would seem then that, apart from the mere presence of the lens, neither position, degree of development, and its particular metabolism (whether avascular or vascular) had any influence in the development of the perfect vitreous (5).

The main assumption to be drawn is that the lens played but a passive rôle in the development of vitreous, C.

The absence of any coarse " primary " vitreous, and the absence of a retinal circulation to absorb it, suggests that the " primary " and the " secondary " vitreous are one and the same thing and that the characters of the " primary " vitreous are overshadowed by its infiltration with the hyaloid system of vessels (6).

" Tertiary " vitreous being absent in this left eye in association with the absence of ciliary body, and the fact that the whole globe was filled with " secondary " vitreous suggests that the " secondary " vitreous is the basis on which the " tertiary " vitreous is differentiated. One might even go so far, in the light of the last paragraph, *vide infra,* as to say that the ciliary body is responsible and, in particular, its pigmented epithelium (absent in this case) which is but a modification of the original neural ectoderm lining the optic cup (7).

The only structure left to form the " secondary " vitreous is the non-vascular lining of the optic cup, which in view of its immaturity must be due to the functioning of its primitive cells, acting by virtue of their inherent determination and their specialised nature. (The neural ectoderm being the most highly " specialised " of embryonic tissue), D.

Clinico-Physiological Interpretation.—We have in this left eye the peculiar phenomenon of normal tension with the absence of the greater part of the mechanism believed to be responsible for its maintenance. There was also a detached retina to complicate the analysis. In the light of the facts available, it would appear that the tension was maintained by the vitreous gel, which completely filled the globe and was supported by the coats of the eyeball.

The next point of interest is the optical and physical perfection of the vitreous which has been maintained *in its augmented state* despite the almost complete absence of vascular structures within this eye. Two possibilities suggest themselves, and they are that:

(1) The *remnants of the choroid* were sufficient to maintain the volume and physical structure of the vitreous at their maximum efficiency (all other vascular structures being absent).

(2) The vitreous when fully determined in development requires no maintenance whatever, and that while hermetically sealed within the globe and not subject to pathological interference retains its efficiency unimpaired.

With regard to the first suggestion, it seems impossible that a choroid lacking capillary development is capable of supporting the vitreous intact by the process of dialysation. It also negatives any suggestion that the vitreous might be supported by the process known, and theoretically interpreted, as the "stagnans aqueous" whereby water and ions pass through the coats of the eye to the vitreous.

We are therefore left with only one alternative, and that is possibility No. 2.

With regard to the absence of aqueous, it has been shown that in this peculiar developmental condition of the eye, aqueous is not essential to the maintenance of normal tension. In this respect it must be remembered that this globe was virtually hermetically sealed as the anterior angle and canal of Schlemm had in all probability been developmentally absent. How much the absence of aqueous affected the nutrition of the capsule of the ectopic lens one cannot say with any certainty, but it is interesting to note the clinical report on this which shows that "it had the appearance of thickened, greasy parchment, and possessed an auxiliary blood supply."

In the normal eye the innermost layer of the retina is nourished by the retinal vessels, while the outer layers are nourished by the choriocapillaris, but in this case the retina, lacking neuronal development, was very thin. On the nasal side (undetached portion) the retina appeared to be nourished by the underlying defective choroid. I am not prepared to say how this occurred, since these larger vessels are not supposed to have the same functions as the more intricate choriocapillaris. On the temporal side there was a complete absence of choroid and the retina was detached and the nourishment was apparently derived from the aberrant equatorial vessels.

The lens not having achieved perfection of its metabolism due in part to its defective differentiation, its abnormal position within the globe, and the absence of aqueous, was also forced to draw

upon the blood vessels from the equatorial region for its structural maintenance. (Preservation of its inherent self-determination.)

Ocular Phenomena.— Right eye: There was a marked "proptosis" of the right eye which was produced by the generalised enlargement of this globe and not by any other agency. It was impossible to close the lids over the eye and the whole appearance of the patient's face was rather grotesque. The globe almost wholly filled the external opening to the orbital cavity, and appeared to have a diameter of about one and a half inches. The cornea was normal in size, being 11½ by 11½ mms., the circumference being more rounded than is usual and the anterior surface of the cornea, more flattened. There were no localised staphylomata, the whole enlargement being due to a generalised stretching. The centre of the cornea showed evidence of a past keratitis in the central area which was faintly nebulous. There was no evidence of corneal vascularisation.

The conjunctiva overlying the sclera was thinned and showed evidence of chronic hyperaemia with a profusion of dilated blood vessels which appeared to stand out from the thinned conjunctiva. The underlying sclera was abnormally thinned, transparent in places and was of bluish-black colour. The lens was in the normal position and showed fine opacities. On the anterior surface there were fine posterior synechiae with a fair amount of pigment deposition. The pupil diameter was three and a half mms. and there was no pupil reaction to light. What could be seen in the posterior aspects of this globe showed that the vitreous was fluid with large and small floaters, some of which appeared to be in the form of "fixed" wavy vertical strings. The fundus was not seen, but in the lateral zone one could see the region of the ciliary body which showed up, as a dense black band about a disc diameter in width, running circularly round the globe, associated with a mass of greyish tissue just *anterior* to it and traversing a similar course. This phenomena was well seen on the nasal side, but was seen with great difficulty on the temporal aspect of the globe. The fundus reflex was so bad that a retinoscopy was impossible, but an estimate of the refraction based on the size of the globe was -35D. The tension at this stage was sub-normal. The ocular movements were seriously curtailed by the size of the globe, by the fact that the muscles were considerably stretched and by the fact that their "physiological points of contact" were situated too posteriorly to permit of the proper action of the muscles.

Certain other points, however, require elucidation. Why did the cornea remain the normal size while the rest of the globe

underwent generalised stretching? The protective mechanism appeared to be the scleral ring reinforced by the laminated nature of the cornea. In all probability also there was a developmental weakness in the sclera since there were no localised staphylomata, and the portion of this eye which should have given way first should have been the nebulous corneal centre. (There was no evidence of keratoconus in this case.)

For cosmetic reasons the patient was advised to have this blind eye removed, and shortly afterwards was admitted to the Romford Old Church Hospital where an enucleation under evipan was performed by Mr. Collyer Summers.

The following details kindly supplied by Dr. Miles, Medical Superintendent of the Romford Old Church Hospital, indicate the nature and progress of the case while in hospital.

Admitted.—February 7, 1939. Right enucleation under evipan, February 10, 1939. Pre-operative examination showed heart and chest normal. No untoward symptoms during operation.

On February 11, 1939, the patient developed aphasia. Temperature, respiration and pulse normal.

On February 16, 1939: slight rise of temperature, pulse and respiration. T. 99·4°. P.R. 104. R.R. 22.

February 17, 1939, the temperature dropped to normal. P.R. 100. At this stage the patient was examined by Dr. Plummer, who reported as follows:

" Patient quite co-operative. Right facial paralysis. K.J. plus " Babinski " equals flexor response. Abdominal reflexes plus. Biceps jerks plus. Hearing normal. Understands perfectly. Heart normal. Diagnosis: Right hemiplegia, cause unknown.

The same evening (February 17, 1939) temperature rose to 98·8° and continued to rise steeply until death.

A rash developed on the body the following day (February 18, 1939).

Death supervened on February 20, 1939.

A post-mortem examination was made to establish the cause of death, and Dr. Marshall's report in full is given below.

Notes on Post-Mortem Examination

Chief points in the history of the case

About six years ago operation on the right eye. Right eye removed here recently. Paralysis: right side— ? duration. Left brachial thrombosis.

External Marks.—Left arm cyanosed. Right eye missing.

Chest and Pleurae.—Negative.

Heart.—Right ventricle thick walled, mitral stenosis—old. Orifice admits one finger only. Aortic orifice small, striations and early atheroma of the ascending aorta. Recent red, ragged vegetation at the origin of the innominate and carotid.

Lungs.—Some congestion and bronchitis.

Glands.—Negative.

Abdomen.—Stomach, intestines and glands negative.

Liver.—Moderate nutmeg.

Spleen.—Small, recent infarctions at the upper border.

Pancreas.—Negative.

Kidneys.—Right and left negative.

Central Nervous System: Brain.—Yellowish discoloration over the left cortical area. (Parietal.) Haemorrhagic mass between the cortex and the basal ganglia.

? Glioma. ?Thrombosis and haemorrhage. 1″1″2″.

Special points.—No chancre or scar on glans. For section: cerebral mass Hist. 48/39. Section shows a thrombus surrounded by scavenger cells. No infection in the right eye socket. Death from cerebral "tumour." Date: February 21, 1939.

Diagnostic Summary

This is embodied in the schematic representation showing the age of the patient at which the various lesions developed.

Birth.—*Congenital maldevelopment of left eye associated with blindness.* (Hereditary.)

Late childhood.—*Chronic Endocarditis* of mitral and aortic *valves.* Causal agent unknown.

Early puberty.—*Defective physical development* secondary to cardiac affection and primary causal agent. (?Rheumatism.)

Late puberty.—*Embolic Phenomena complicated by aphasia* following a dental operation.

One year later.—*Metastatic uveitis with blindness* in right eye suddenly intervenes without apparent cause, secondary glaucoma follows. *Probable reacerbation of sub-acute bacterial endocarditis,* with lodgment of emboli in post-ciliary arteries and choroid of this region.

Three years later.—Enucleation of grossly enlarged globe performed, followed by aphasia again, but in association with right hemiplegia. Death supervenes. *Patient has developed a fulminating malignant endocarditis,* complicated by cerebral embolism. The main feature being that the vegetations were attached to the atheromatous aorta and innominate (L) artery, and not to the old sclerosed mitral valves.

General Summary

Evidence of certain rare congenital abnormalities is given.

Complex factors operating to produce total blindness in a single patient outlined in detail.

Congenital affections of the globe have been shown to have embryological and developmental significance, when analysed in relation to " time " in development and to the primitive tissue layers.

The development of the vitreous is " proved " by clinical observation.

A strong hereditary tendency to maldevelopment of globe is shown in relation to congenital cerebral maldevelopment in other members of the same family.

Gross cardiac affection has been shown to be present, of long standing, without obvious signs of this condition. The appearance of a fulminating endocarditis without previous evidence of infection and in the presence of an aseptic orbital wound has been demonstrated.

Embolic phenomena following on this endocarditis and terminating fatally have been outlined.

Acknowledgments.—I desire to thank Dr. W. A. Bullough for permission to publish details of this case, to Dr. Miles for records of the case while in the Old Church Hospital and to Messrs. Clement Clarke for their unfailing courtesy and assistance in reproducing my original fundus sketches.

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A CASE OF GAUCHER'S DISEASE WITH BIOPSY OF THE TYPICAL PINGUECULAE

BY

TERENCE EAST *and* L. H. SAVIN

LONDON

OF recent years eye signs have been described in most of the lipoidoses. In Gaucher's disease according to McNee (1937) "the eyes show a phenomenon which is so constant as to be almost pathognomonic:—a brownish-yellow wedge-shaped thickening or pinguecula appears first on the nasal and then on the temporal side of each eye."

The disease is sufficiently rare to justify the clinical and histological description of such a case. The first description by Gaucher (1882) was of an apparently idiopathic enlargement of the spleen of a girl who had undergone severe privations during the siege of Paris. He noted that the skin was slightly jaundiced, and the conjunctivae yellowish towards the inner angle of the eyes. Sections of the spleen showed large cells, staining with difficulty. In the light of the pathological knowledge of the time the most likely diagnosis seemed to be primary epithelioma of the spleen.

Subsequent descriptions have slightly clarified the clinical picture. Gaucher's splenomegaly is often a familial disease, more common in females than in males. Jews are especially susceptible. Splenomegaly is associated with anaemia and a haemorrhagic tendency (Ellis, 1938). The skin is yellowish-brown, with often a leaden pigmentation on head, neck, hands, and legs. A malar flush is common. Myopia is found in many cases (Bloom, Groen, Portna, 1936). The liver may be enlarged also. The lower end of the femur may show a bottle-shaped enlargement.

The disease often lasts many years with comparatively little general disturbance. Death eventually takes place from inanition, haemorrhage, and intercurrent infections. There may be terminal mental defect.

Post-mortem the spleen is much enlarged. The cut surface shows greyish-white or yellow from masses of Gaucher cells. These are not epitheliomatous, as Gaucher thought, but are lipoid storage cells of the reticulo-endothelial system. They are 20-80μ across, with many small, pyknotic, eccentric nuclei. They stain badly with the fat-staining dyes, and are packed with a cerebroside—kerasin—soluble in alcohol but not in ether. Kerasin is rather an inert substance chemically. On acid hydrolysis it splits up into d.galactose, lignoceric acid, and sphingosine, a base with a complicated molecule said to contain 18 carbon atoms.

The spleen may also show cavernous foci, fibrous nodules, small infarcts. The liver is less enlarged in proportion, often cirrhotic, showing Gaucher cells. The lymph glands though not grossly enlarged may be involved. The long bones, vertebrae, and skull contain numerous Gaucher cells. Haemorrhages may be found in the internal organs.

In our own case the details were as follows:—The patient was a telegraph maintenance officer, aged 59 years, who complained of fatigue, quite noticeable towards evening, so that he had no energy to do anything. This lassitude had come on after a prolonged attack of influenza six months previously. Since a heavy cold a month ago he had noticed breathlessness on going upstairs. His mouth had been rather sore for a month.

His past history was free from disease except for malaria and typhoid fever many years ago.

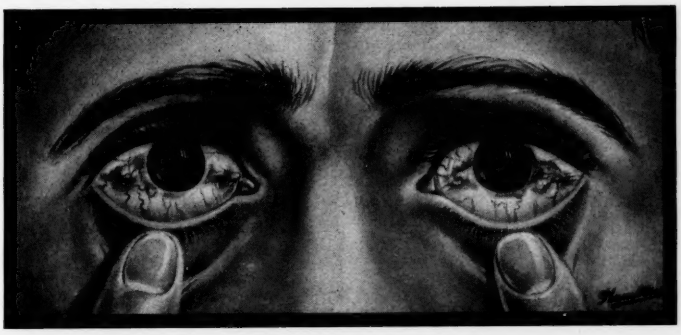
There was nothing of note in the family history.

He was a thin man, with rather a dusky complexion. There were faint irregular areas of brownish pigmentation on the face, especially on the cheeks and forehead. The backs of the hands were unusually brownish. Telangiectatic venules were conspicuous on the nose and cheeks. The eyeballs were yellowish. On either side of the cornea in each eye were pingueculae, triangular in shape, rather granular in appearance and of a brownish-yellow colour. They were more raised and brown and larger than the pingueculae often seen on the eyeballs of elderly people. The illustration gives a good idea of the appearance of this patient's eyes. He was emmetropic.

The abdomen was thin, and the huge spleen was easily seen and felt. It was hard and smooth and not tender. He was quite unaware of the splenic tumour and had suffered no discomfort in that region. The liver was slightly enlarged and very firm, with a blunt edge and smooth surface. There was no ascites; no glands were enlarged. On the lower part of the left leg just above the ankle was a purplish brown pigmented area, resembling that seen in cases of old varicose ulceration. The surface of the skin was dry and scaly. There had been no spontaneous haemorrhages into the skin or mucous membranes, such as sometimes occur in Gaucher's disease. The other organs were normal.

Investigations

There was some degree of anaemia, which was no doubt responsible for his symptoms. The red cells were 3·22 million per c.mm. The haemoglobin was only 64 per cent., so the colour index was 1·03. The leucocytes were 5,400 per c.mm., not reaching the degree of leucopenia of some cases. The differential count was normal. There was slight variation in size and shape of the red cells, with occasional nucleated cells. The reticulocytes were 3·7



Pingueculae in Gaucher's disease. Note, that the brownish-yellow pigmentation is not appreciable in the reproduction in monochrome.

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per cent. The platelets were not diminished as is sometimes the case. The Wassermann reaction was negative. The blood cholesterol was normal, as is usual in this disease. The fragility of the red cells showed a very slight increase to subnormal solutions of saline (Dr. Dacie).

The liver defect, presumably lipoid infiltration, was no doubt responsible for the raised bilirubin in the blood, for the van den Bergh reaction gave 1·5 units of haemobilirubin. The presence of bile salts in the urine would be due to the same cause. The tolerance to laevulose was normal.

Skiagrams of the long bones showed no enlargement or rarefaction due to lipoid deposits.

Biopsy of the pingueculae was done by one of us (L.H.S.). We are indebted to Dr. H. A. Lucas for a report on the microscopical sections. "Situated beneath the epithelium are small collections of large endothelial cells. The cytoplasm of these cells is degenerate and shows a foamy appearance. The frozen sections show no fat-staining particles. The absence of fat-staining and the foamy appearance of the cells is similar to that observed in the endothelial cells of the spleen in cases of Gaucher's disease. The small amount of tissue available made further investigation impossible. The histological findings are compatible with Gaucher's disease."

Dr. Grey kindly attempted to analyse a fragment for kerasin, but it was too small for him to get any result.

Comment

The case presents the features of Gaucher's disease, with involvement of the liver, and the usual slight anaemia, and typical pingueculae. The microscopical findings of the biopsy of the pingueculae are of interest, and we have not been able to find histological records of other cases. These lipoid deposits on the eyeball are so peculiar and striking that it seems worth while to draw attention to them.

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CEREBRAL FAT EMBOLISM WITH RECOVERY: AND INVOLVEMENT OF THE CENTRAL RETINAL ARTERY

BY

J. JAMESON EVANS

BIRMINGHAM

THE condition of cerebral fat embolism is considered to be fatal in the majority of cases and recovery is rare. Indeed the clinical syndrome of cerebral fat embolism is not as universally recognised as might be expected in an age in which an increased number of such cases is to be expected as a result of the mounting toll of the roads. Corlette (1925) has given a clear description of the characteristics and also records one of the few instances of recovery. He mentions the association of delirium with a pulse of low tension, coming on some hours after the initial injury, passing to coma with hyperpyrexia, the frequency of incontinence of urine and faeces, and the appearance of a petechial eruption in the majority of cases in from twelve hours to three days. This latter sign and the sudden passing from consciousness to coma without the accompaniment of cerebral symptoms are pathognomonic. Corlette's case which recovered showed symptoms of cerebral fat embolism some thirty-six hours after the accident and had recovered in three days. Unfortunately there is no note of any examination of the fundus oculi. Dahl (1924) records three cases of recovery. Benestadt (1911) also reported three cases which recovered, but none of these reached the stage of coma, although all showed some degree of delirium. Some of the cases reported have, however, shown no degree of hyperpyrexia, while those of Benestadt showed only slight rise of temperature. In these cases petechiae were observed on the third day. This paper contains no note of observations of the fundus oculi nor of any visual disturbances.

The present case is notable for the absence of initial head injuries and for the speediness of recovery, as well as for involvement of the retinal arteries in both eyes. The details of this case may be summarised as follows, from notes supplied by Mr. W. H. George, Dudley Road Hospital, the Surgeon in charge of the case, whose clinical acumen led to the diagnosis of this case.

F.R., aged 23 years, suffered a road accident on June 21, 1938. On June 22, he was admitted to hospital where his condition was briefly this:—Patient was drowsy but conscious; he answered questions intelligently but had no recollection of the accident. There were numerous bruises and lacerations of the right arm,

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shoulder and leg. There was a fracture of the right tibia and fibula some four inches above the ankle, with considerable displacement, a star-shaped fracture of the right patella, and an oblique fracture of the right ulna extending to the elbow joint.

These fractures were dealt with the same day under open ether anaesthesia, the leg being manipulated and set up in plaster.

On June 23 the patient became very drowsy and this was more marked on the following day, when he reached a condition of surly sub-coma, and became incontinent of urine. A petechial rash appeared on the chest and neck and there was transient squint of the left eye. Lumbar puncture gave a clear fluid under normal pressure, the urine contained fat globules but was otherwise clear, the blood showed a high percentage of fatty acids.

On June 25 the patient was still very drowsy and incontinent but could be made to answer questions. He was unable to recognise his relatives at this time. The appearances of the fundi on this day were of interest as showing the involvement of the retina in the process of fat embolism. The external appearance of the eyes was normal. The pupils reacted to light and at no time was there any complaint of disturbance or defect of vision. The tension was normal in each eye and the media were clear. The ophthalmoscopic picture was exceptionally striking. There was diffuse oedema of the retinae over the whole of the posterior poles, suggestive of shallow retinal detachment, with the retinal vessels standing out prominently, but without any material variation of size, calibre, or tortuosity, and no segmentation of the blood columns. Retinal oedema was definitely more pronounced in the macular area, where also three slightly crescentic areas of intensified pallor were noticeable: one at least of these whiter areas appeared to be in the deeper layers of the retina. (Plate).

In the right eye, well outside and below the macula and towards the periphery, there were two large sub-hyaloid haemorrhages, each more than a disc diameter in size, under one of which a vein could be seen to pass. In the left eye a similar but smaller haemorrhage was seen near the periphery on the nasal side.

On June 29 the patient's mental condition began to improve, and he became continent of urine.

On July 6 he was so recovered as to be reading a book with interest. On this day ophthalmoscopic examination showed that the oedema of the retinae was much less, but there still remained haze, pallor and shot-silk appearance in the central area. The sub-hyaloid haemorrhages were showing early reabsorption.

On August 11 vision in each eye was 6/6 without glasses. There was still a small remnant of the larger of the sub-hyaloid haemorrhages to the outer side and below the macula but the smaller had

become completely absorbed. In all other respects the appearance of both fundi was absolutely normal.

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ANNOTATION

The Man and the Machine

It was natural in the early days of aviation that more attention should be paid to the newly invented and rapidly developing machine than to the man who worked it. In a paper on "Pilot Fitness" published in this number, Drs. Ferree and Rand lay great stress on the neglect of the human factor in aviation. It is probable that the indictment is true of the Air Forces of most nations, but it is certain that this factor early received attention in England. The R.F.C. was fortunate in having for it first Director General of Medical Services, General Sir Mathew Fell, and for its second, Air Vice-Marshal Sir David Munroe, who gathered around them an enthusiastic band of men, of whom Group Captain Flack was a specially distinguished pioneer in many branches of medicine as applied to the specific problems of aviation. An advisory medical committee was also instituted, but it must be admitted that it was not so constituted as to be ideal for a service which demanded research into the many new and difficult problems which flying men had to face. The R.A.F. from an early date had a very elaborate and admirably constituted committee on Aeronautical Research. In due course it was recognized that the human factor was as important as the machine, and a Personnel Research Committee was set up to deal with the physiological, psychological and pathological factors involved in flying. The problems to which Drs. Ferree and Rand refer have therefore by no means been neglected in England, and possibly some of the success of our aviators since the War began is to be attributed to this fact.

ABSTRACTS

I.—CORNEA

(1) **Picillo (Palermo). — Tropho-degenerative adiposia of the cornea. (Sull' adiposi di trofico-degenerativo dell' cornea).** *Ann. di Ottal.*, October, 1939.

(1) **Picillo** gives the histories of two cases of this rare affection. The first, a girl, aged 20 years, had noted for eight months a sensation of a foreign body in the right eye; after about a month she had seen a spot on the inner side of the cornea which had grown steadily.

There was no evidence of trachoma; on the inner side of the cornea extending on to the sclera, there was a yellow patch about 6 mm. in height and 4 mm. broad. A fragment was excised and examined; the epithelium and the anterior layers of the cornea were little changed; the parenchyma showed oedema, and the lamellae were separated by spaces. The posterior layers were much altered; the lamellae were replaced by a network of fibres which had no resemblance to the normal tissue; the spaces of the net were filled with fatty substance.

The second case was an older woman who had suffered from trachoma; she had noticed for some years a white spot in the right cornea (where there had been an ulcer). The opacity was less deeply placed in the cornea than in the first case. A piece was removed by a trephine and examined. As might be expected after old trachoma, neither the epithelium nor the superficial layers of the cornea were normal. The epithelial cells were irregularly arranged, and showed vacuoles especially among the basal cells.

There was no trace of Bowman's membrane. The cornea was replaced by fibrous tissue whose spaces were filled by fatty masses. The fat had penetrated among the basal cells of the epithelium.

In conclusion, Picillo discusses the nature of the change; he considers it to be a degeneration in most cases but that there is also a dystrophy; it seems that an alteration in the metabolism of fats may contribute to the appearance of such a change as was observed in Picillo's first case.

HAROLD GRIMSDALE.

(2) **Valerio (Milan).—Two rare forms of corneal degeneration. (Due forme rare di degenerazione giovanile della cornea).** *Boll. d'Ocul.*, August, 1939.

(2) **Valerio** has observed recently two cases showing degeneration of the central region of the cornea of types hitherto undescribed. The first was a young man, aged 25 years, seen at the beginning of

1938, with a history that he had noted slight visual defect. After a slight injury, the corneal change was noticed by the surgeon attending him, and he was advised to go to hospital. The centre of each cornea showed a central greyish yellow disc some 4 mm. in diameter; the surrounding cornea was normal. Sensation was lessened over this disc; there was no other abnormality seen. Examination with the slit-lamp showed that the opacity was made up of small masses arranged in a sort of mosaic; in the middle of the disc there was a space free from these masses and through this opening could be seen the corneal tissue with scattered grey points. It could be seen that the opacity was situated in Bowman's membrane and that the cornea had a normal thickness. There were no new vessels; tension was normal; R.V. 5/10; L.V. 5/15 not improved. Nothing was found to throw light on the condition. He was watched for some 18 months, during which time there was no alteration noticed in the appearance or in the visual acuity. the author has not been able to find any case in a young man, at all like this; Vogt recorded a somewhat similar condition in an old man, under the name of "crocodile scale of Bowman's membrane." In the second case, also a young man, there was a central opacity in the cornea, which was seen to be made up of many fine needle-like opacities about 2 mm. long and of brilliant white colour with coloured reflections. These seemed to be crystals. By the slit-lamp it could be seen that these bodies were situated in the substance of the cornea beneath Bowman's membrane. Vision was 6/10 in both eyes, improved to 8/10 by the addition of −0·75 D.sph. Nothing abnormal of importance was found in the general health.

The author compares this case also, with one reported by Vogt, in which he discovered crystals, deep in the cornea, which he thought to be cholesterin, or perhaps, uric acid. This patient was elderly.

HAROLD GRIMSDALE.

(3) **Orzalesi (Naples).—Respiration and glycolysis of the cornea. (Ricerche sulla respirazione e sulla glicolisi della cornea).** *Boll. d'Ocul.*, July, 1939.

(3) **Orzalesi** has examined these functions in the cornea of rats and rabbits, and in one instance, in man. He finds the amount of oxygen consumed and the glycolysis greater in the rat than in the rabbit and in both, than in man. He finds, also, that the chief activity is in the corneal epithelium; and in the parenchyma, a much less exchange. He concludes that the differences found in the different species are due to varying amount of parenchyma. He concludes that the endothelium has an important share in the respiratory process though he has not been able to devise a satisfactory way of separating the endothelium for examination.

HAROLD GRIMSDALE.

(4) **Orzalesi (Naples).—The glycolysis and respiration of the cornea in albino rats lacking vitamin A. (Ricerche sulla glicolisi e respirazione di ratto albino in avitaminosi A).** *Boll. d'Ocul.*, June, 1939.

(4) The pathogenesis of keratomalacia is uncertain; it is most commonly held to be the result of a neuro-trophic lesion. Some regard the loss of lytic power of the tears as of first importance. It is stated that instillation of normal tears will prevent the occurrrence of keratomalacia. It has been suggested that study of the metabolism of animals in avitaminosis A may throw light on the condition. **Orzalesi** has estimated the respiration and glycolysis of the corneae of a number of albino rats, comparing it with that of normal rats. Equal numbers of rats were fed on normal diet and a diet wanting vitamin A. As soon as keratomalacia was observed in a rat, it and its opposite number were killed and the corneae examined; it was found that both respiration and glycolysis were more active in the avitaminotic animals. Orzalesi discusses the probable cause; he shows that in the diseased cornea there were marked changes of a necrotic nature which seemed to set free substances accelerating the metabolism of the tissues. New cells also coming in, had a similar effect.

HAROLD GRIMSDALE.

(5) **Scherschewskaya, O. J. (Novosibirsk, U.S.S.R.)—Keratoplasty with grafts preserved in formalin. (Keratoplastische Versuche mit Anwendung von formollappen).** *Ophthalmologica*, Vol. XCIX, p. 4, 1940.

(5) **Scherschewskaya** reports on a series of animal experiments to test the validity of corneal transplants fixed in formalin (method of Weidenreich). The graft took in 12 out of 37 rabbit eyes, though eight of these grafts were opaque. Partial perforating keratoplasty with formalin grafts performed on five patients gave one transparent, one semi-transparent and two opaque grafts.

ARNOLD SORSBY.

(6) **Bürki, E. (Basle).—Macular corneal dystrophy. (Ueber fleckige Hornhautdystrophie).** *Ophthalmologica*, Vol. XCVIII, p. 311, 1940.

(6) **Bürki** describes a new pedigree of macular corneal dystrophy which bears out Bückler's views that the condition is recessive There were two certain cases in two generations of an extensive family, the two patients showing similar features with no tendency to transition to other forms of corneal dystrophy. Consanguinity was present in one case.

ARNOLD SORSBY.

(7) **Haldimann, C. (Berne).—Sympathetic ophthalmitis and herpetic keratitis. (Sympathische Ophthalmie und Keratitis herpetica).** *Ophthalmologica*, Vol. XCIX, p. 187, 1940.

(7) **Haldimann** draws attention to the histological picture of sympathetic ophthalmitis reported in the literature on herpes ophthalmicus and describes two personal cases. The first was a case of sympathetic ophthalmitis after keratitis metaherpetica. The diagnosis was confirmed by the histological examination of the eye first affected. Damage by perforation could be excluded. The second case was due to an endogenous spread of keratitis disciformis to the second eye after several relapses in the first eye: inflammation developed on the posterior surface of the cornea, centrally, in the second eye together with optic neuritis. Later on, the outer surface of the cornea became affected; the condition was cured with intravenous injections of atophanyl-cylotropin.

ARNOLD SORSBY.

II.—MISCELLANEOUS

(1) **Barrett, Sir James (Melbourne).—Medicine in Australia and refugees.** *Australian Quarterly*, March, 1940.

(1) **Sir James Barrett** discusses the problem of medicine in Australia and Refugees. There are four Schools of Medicine forming an integral part of the respective Universities, *viz.*:—Melbourne, Sydney, Adelaide and Queensland. At Melbourne, the first Director of the School, Professor Halford, influenced the council to establish a curriculum of five years, half to be spent in biology and half in clinical work. The number of practitioners per thousand of population appears to be less than that obtaining in Great Britain; *e.g.*, Victoria, 1 per 1,200; S. Australia, 1 per 1,300; N. South Wales, 1 per 1,400; Queensland, 1 per 1,500; W. Australia, 1 per 1,330; and Tasmania, 1 per 1,700. Of 56 hospitals in being, three are in chronic difficulties for want of practitioners, and four others have been closed . . It is estimated that 60 per cent. of Melbourne practitioners are engaged in honorary work in the Metropolitan hospitals. At present three Bush Nursing Hospitals are staffed by three alien practitioners. It is clear that there is a shortage of medical practitioners in the country. This introduces the refugee problem. Before the War there was reciprocity with Great Britain, N. Zealand, S. Africa, and Italy. The only aliens capable of registration in all states of the Dominion were Italians. A number of Czechs, Austrians, Poles and Jews have recently been

admitted to Australia, but in general are not entitled to registration. Some concessions have already been made. The Universities of Sydney, Adelaide and Queensland admit approved alien graduates to examination at the end of the third year and thence to a three years' course of study and examination. At the end of the third year they receive a certificate entitling them to registration in Sydney, and to a degree and registration in Adelaide and Queensland. Melbourne only releases them from one year's study, and requires a five year course. It has been estimated that Australia will produce 240 medical graduates per annum, which will continue till 1944 at least. To maintain the present concentration, Professor MacCallum estimates that 119 new graduates must be produced annually. The annual loss by death is 75, and others drop out through age and ill-health.

Summing up, Sir James Barrett says that "so far only 91 medical or dental practitioners other than Italians, have been admitted into Australia during the 18 months ending 31st December, 1939. Many of them cannot register and have to seek other occupations. All those who have done a five years' course and passed the necessary examinations in the British Empire (except possibly Canada) are registerable in Australia.

Thus so far there can be little just criticism in Australia . . . but the shortage in the country continues, and may be remedied by (1) state subsidy: or (2) by the employment of aliens,

But as Professor MacCallum states (3) it may also solve itself, but for the moment the position is very difficult. Practitioners are wanted in the country and are difficult to obtain. It is not true that the country population is declining, but it is not increasing nearly as rapidly as the population of the cities as a reference to the Commonwealth Year Book indicates."

R. R. J.

(2) **Lagrange, Henri, and Goulespre, Jean (Paris).—Iridocyclitis and focal infection. (Irido-cyclite et infection focale).** *Ann. d'Ocul.*, Vol. CLXXV, p. 494, July, 1938.

(2) Three cases are described in which operative treatment of the accessory sinuses was followed, within a few hours or days, by the cessation of iridocyclitis. A positive Wassermann result had been noted in two of the cases, but anti-syphilitic treatment had wrought no apparent improvement in the eye condition.

In discussing causation, the authors point out that the theory of reflex nervous irritation cannot account for cases in which the focus of infection forms no direct nervous link with the eye. The theory of blood-borne bacterial infection, they point out, is also insufficient, because it fails to explain the sudden, dramatic resolution of

iridocyclitis occasioned by treatment of the primary focus. They conclude that an allergic reaction is originated by the focus of infection, which thus behaves as a sensitising agent. This reaction expresses or "exteriorises" itself in the reticulo-endothelial system, represented in this instance by certain cells in the base of the iris and in the ciliary processes.

J. H. DOGGART.

(3) **Michail, D. (Cluj).—Symmetrical lymphomata of the lacrymal glands. (Sur les lymphomes symetriques des glandes lacrymale).** *Ann. d'Ocul.*, Vol. CLXXV, p. 565, August, 1938.

(3) After reviewing the literature on this subject, **Michail** describes two cases, of which the first occurred in a woman aged 30 years, who had recovered from typhoid one year previously. Histological examination revealed perivascular cuffing, and replacement of much glandular tissue by lymphocytic infiltration. The second case was a man aged 21 years, in whom removal of the orbital tumours was followed two months later by left-sided recurrence, together with the development of bluish cutaneous plaques scattered over the face, trunk and limbs; similar formations displayed themselves in the left parotid gland, left half of the hard palate, and on the left sclera and cornea. Biopsy revealed intense lymphocytic infiltration. All these lesions disappeared after a course of radium and X-ray therapy.

In neither of these cases was there any evidence of syphilis, tubercle, or disease of the haematopoietic system.

J. H. DOGGART.

(4) **Redslob, E. (Strasbourg).—Contribution of the study of the the origin of retinal detachment. (Contribution a l'étude de la genese du decollement retinien).** *Ann. d'Ocul.*, Vol. CLXXV, p. 657, September, 1938.

(4) **Redslob** has made a histological study of an eye showing a small retinal detachment at an early stage. Excision had been performed on account of suspected sympathetic ophthalmitis, several months after a perforating injury. The retina and choroid were not implicated in the injury, but a minute detachment was found a little behind the equator. Oedematous transudate intervened between the pigment layer and the rods and cones. Numerous blebs were visible within the substance of the retina, especially in the outer layers. At one point a vesicle involved the inner part of the retina, covered by so fine a layer of tissue that it would obviously have burst at any moment.

Three changes were noted in the choroid at the situation of the detached zone of :—

1. Thickening mainly due to engorgement of the veins.
2. Sclerosis from the deposition of fibrous tissue.
3. Fibrous cuffing of arteries,

The author stresses the strict localization of these choroidal changes to the immediate neigbourhood of the detachment, the rest of the choroid being perfectly normal. In his opinion the primary cause of detached retina in this case was a change in the choroid, leading to the formation of a transudate which penetrated the pigment layer and invaded the retina. When the primary cause is in the vitreous, a retinal hole is inevitable; choroidal cases on the other hand, often show no hole, although, of course, a hole may be formed secondarily, by rupture of the thinned layer of retina overlaying a cyst.

The reviewer cannot help wondering why it is that a retinal hole hardly ever forms in renal retinitis accompanied by detachment. Even in those comparatively rare cases where the retina is bowed forward like a sail, the attenuated membrane can resist the impact of this abundant transudate without bursting, and in many instances recovers full function when the fluid ebbs away.

J. H. DOGGART.

(5) **Kraupa, E.—Transitory amblyopia after cataract extraction. (Transitorische Amblyopie nach der Staroperation).** *Ophthalmologica*, Vol. XCVIII, p. 300, 1940.

(5) **Kraupa** draws attention to those cases of cataract extraction which do not reach full vision until some time after the operation. He discusses the possibility of this transitory amblyopia being due to disturbed macular circulation, possibly caused by the irritation from the incision.

ARNOLD SORSBY.

(6) **Bangerter, A. (Berne).—Cataract in native sprue. (Katarakt bei einheimischer Sprue).** *Ophthalmologica*, Vol. XCVIII, p. 291, 1940.

(6) In describing two cases of rapidly developing cataract in native sprue, **Bangerter** argues that this was not an accidental association and discusses the possible general factors that might have led to the lens changes.

ARNOLD SORSBY.

BOOK NOTICES

Text-Book of Ophthalmology. By Sir STEWART DUKE-ELDER, M.A., M.D., F.R.C.S. Vol. III, pp. 1,400, 1,140 illustrations, including 164 in colour. Publishers: Henry Kimpton. Price, £3 10s. 0d.

The third volume of Duke-Elder's Text Book of Ophthalmology is concerned with the diseases of the inner eye and comprises sections dealing with the uveal tract, the retina, the optic nerve, the lens, the vitreous body, glaucoma and hypotony, and intra-ocular parasites.

Each of these is treated with a wealth of detail which would be impossible in a smaller volume. So wide has been the author's search through the literature of the world that the general effect on the reader is to make him feel as though he were attending an international congress on ophthalmology, and could understand all that was being said. There are, for example, nearly 500 references at the end of the section dealing with detachment of the retina.

A result of this is, that time and again when reading this book one comes across statements which supply just that bit of information which subconsciously the reader has been needing, and one says to oneself "that explains it"; "it" being some particular point in pathology or clinical work which has hitherto proved puzzling. Two examples may perhaps be taken to illustrate this. The first concerns malignant melanomata of the choroid, in which it has always seemed odd to the reviewer that extension through the globe should so frequently occur along the lines of the penetrating nerves rather than the vessels. The difficulty is explained, however, by the suggestion that these tumours are probably derived in the first place from the cells of Schwann and in the nerves themselves. The second example is provided by the description of the choroidal circulation in which it is pointed out that the macular region of the choroid is a semi-independent vascular bed, controlled by one of the posterior ciliary arteries, thus giving at any rate one clue to the localisation of degenerative senile changes in this region. As was done in previous volumes, the author has prefaced each of the main sections by a photograph and a short biographical sketch of one or more of those whose work has entitled them to special association with the subject under discussion.

In the section dealing with diseases of the uveal tract, the author wisely considers the tract as a whole before going on to describe the affections of its component parts, and he has many interesting things to say on the subject. Thus we have his statement on involvement of the uveal tract in systemic infections in which he says that a large number of such cases "are due to an infective

element which ordinarily is a common and minor event occurring intermittently in apparently healthy persons without mishap and giving rise to no systemic clinical evidences, but which in the presence of tissue allergy, at once assumes unwarranted importance, the primary aetiological factor being the condition of sensitisation of the local tissue rather than the virulence of the causal infective organism." In spite of insisting on the importance of the allergic factor in these diseases, the author is not content to "leave it at that," but goes on to describe the various sources of focal infections and sums up his remarks with the observations that "the most common infection is streptococcal, tuberculosis acting allergically from a focal lesion, usually in a mediasterial gland, probably comes second" thus maintaining a nice balance between the Continental and Anglo-American schools of thought. This sense of balance is preserved throughout the whole book and in no part of it does the author allow himself to be carried away by personal bias.

The thoroughness with which the work has been done is another characteristic of this book. Thus in describing primary neuro-epiblastic tumours of the retina, reference is made to no less than five different types of growth, and in describing experimental cataract, this is done under nine main headings with various subsections in which the underlying physiological and pathological factors are discussed in extenso. In spite of this, however, or perhaps because of it, the reader's attention never flags and the book is quite a difficult one to put down. In many parts, the phraseology is particularly happy. For example, the pseudo fibres and pseudo membranes of the vitreous as seen with the slit lamp are described as "appearing to hang like delicate gossamer curtains of moiré silk, full of folds and pleats and moving slightly and characteristically in a pendulum like motion with movements of the eye." Or again, in summing up the chemical changes in cataract, the author employs the art of antithesis by saying that these involve "a hydration followed by a dehydration, an acidification followed by an alkalosis, a replacement of soluble by insoluble protein . . ."

A particularly valuable feature of this book is the illustrations, which number almost as many as it pages. They are remarkably clear and serve admirably to illustrate the descriptions of the various pathological conditions. The publishers are to be congratulated on the reproduction of these and on the general format of the book which is well up to the standard set by the previous volumes. The proof reading must also have been meticulously carried out, the reviewer having been able to detect only four errors, and these only of a minor character in the course of 1,400 pages.

It is not easy to find phrases adequate to express the excellence of this volume and one's gratitude to the author for having written it. It is certainly a sine qua non for every ophthalmologist who

would wish to have a sound and fundamental grasp of his subject, because, however wide his reading of current literature may have been, he will find in this book some knowledge which would otherwise have escaped him. The book is more than this, however, because the production, in the midst of a world war, of a treatise so detailed, learned and eminently readable, is an indication of how well the spirit of this island can react to the noxious stimuli of Nazi aggressiveness.

We are sure that all English-speaking ophthalmologists will be proud of this latest edition to their literature and will wish to congratulate the author on his achievement.

CORRESPONDENCE

CYCLODIATHERMY PUNCTURE IN GLAUCOMA

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—Your issue of June last contains a translation of a paper by Dr. A. Vogt on cyclodiathermy puncture in cases of glaucoma. He bases a strong recommendation of this procedure on an experience of "hundreds" of observations extending over a period of three years.

In his enthusiastic advocacy of C.D.P. he contrasts its freedom from dangerous sequelae with the liability of the sub-conjunctival filtration methods (the decompressions), to these complications.

According to Vogt "sympathetic ophthalmitis has so far never been observed after C.D.P." but is "especially frequent after trephining and iris inclusion."

Readers can place their own eclectic value on the first part of this statement, it obviously needs augmentation and confirmation by other observers, if it is to have any statistical scientific importance.

The second assertion quoted, however unfortunate Vogt's personal experience may be, can hardly be accepted as fair criticism of "all those methods with sub-conjunctival filtration."

In an experience of over 3,500 decompressions, composed of cases operated on by me and my former colleague, Dr. Koman Nayar or associates and visiting ophthalmologists under our supervision, extending over a period of 18 years ending April 1937, there was not a single instance of sympathetic ophthalmia. Nor have I come across a case of sympathetic ophthalmia in decompressions performed by my predecessors at the Madras Clinic, many of

whose patients I was enabled to inspect, nor in my private practice which would raise the figure given by several hundreds.

In a communication on sympathetic ophthalmia, one of a series presented by the Staff of the Government Ophthalmic Hospital, Madras, Koman Nayar gives the figure 0·003 per cent. as the rate of occurrence in all eye cases attending the Madras Clinic over the period of 15 years ending 1935. (*Proc. All Ind. Oph. Soc.*, Vol. IV, 1935.)

My own exceedingly limited experience of C.D.P. as performed by others is distressing, but it would be unfair to infer from this that it may not find a useful place amongst the various operative methods of dealing with abnormal intra-ocular tension. I should be very sorry to employ C.D.P. experimentally on high tension eyes, other than those which were already blind, without first observing a consecutive series of operations by Vogt and following them up for a reasonable time.

It would be quite justifiable and relatively easy for observers in India to repeat Vogt's C.D.P. work on eyes blind of chronic glaucoma in which a lowering of tension is indicated.

Yours truly,

ENGLAND. ROBERT E. WRIGHT.

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—Especial emphasis is, I consider, desirable upon one matter to which reference is made in the interesting paper by Savin and Tyrrell in the November number of the Journal.

Comment No. 7 on p. 564 is as follows:—"If proctocaine is employed for the relief of pain in a blind eye, all possibility of neoplasm should be excluded (see case *n*)." Case *n* referred to a patient who had refused enucleation that had been very wisely recommended in the belief that the glaucoma was due to central vein thrombosis.

In 1925 I reported upon 402 consecutive cases of blind painful eyes that had been excised at Moorfields Eye Hospital during a period of two to three years.* The word "blind" was used to denote "almost blind, and useless." In two of this series an operation had been performed in the hope of saving the eye. Fortunately the wound of operation—for iridectomy—failed to heal, and the eye was in each case enucleated a few days later. Each of these eyes as well as 14 others, *i.e.*, 4 per cent.. contained a sarcoma of the choroid. In a considerable proportion of such cases, owing to corneal haze the result of increased tension, or to secondary or senile cataract, the interior of the eye cannot be examined.

Brit. Jl. Ophthal., Vol. IX, p. 625, 1925.

I therefore propounded a rule to be observed in all cases of eyes which were painful, the subject of glaucoma and practically blind in persons of middle age or older. This rule should especially be emphasised when the fellow eye shows no sign of primary glaucoma. The rule is, "a blind painful glaucomatous eye in a middle-aged person, in which the fundus is invisible, should be excised."

"All possibility of neoplasm" cannot be excluded in the above circumstances. I repeat, therefore, with particular emphasis the desirability for the employment of the rule proposed.

Yours faithfully,

HUMPHREY NEAME.

P.S.—Attention may with advantage be drawn to the abstract on p. 572, *Brit. Jl. Ophthal.*, of November, 1940, in which Larsson describes (*Acta Ophthal.*, Vol. XVII, p. 297, 1939) a method of increasing the transparency of the centre of a glaucomatous hazy cornea by pressure.

56, PORTLAND PLACE, W.1
11th November, 1940.

NOTES

Eye Hazards in Industry.

The Executive Director of the National Society for the Prevention of Blindness, Mrs. E. B. Merrill, pointed out as long ago as September, 1940, that with the expansion and speed-up of industrial production, made necessary in the States by national defence plans, an increase in the hazards which result in eye injuries and other types of accident is bound to occur. The National Society has seized time by the forelock in appointing a strong Industrial Advisory Committee to help in dealing with these problems and other matters concerning the protection of workmen from eye diseases and eye accidents. The Chairman of this Committee is Dr. Leonard Greenburg, Executive Director of the Division of Industrial Hygiene, New York State Department of Labour. With him are ten other prominent citizens of the United States representing many sides of labour problems. The Ophthalmic Surgeon is Dr. M. Davidson, of New York City, and Dr. Donald M. Shafer, Consultant Committee on Healthful Working Conditions, National Association of Manufac turers, New York City, is also a member of the Committee.

We note too that the Society is engaged in an exhaustive study of the entire problem of eye hazards in industry which is nearing completion. The publication of this report will be eagerly awaited in this country as well as in the States.